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DERWENT-ACC-NO: 1998-409009
DERWENT-WEEK: 199904

TITLE: High-heat conductivity material for heat exchanger, heat pump and heat slinger for electric circuit protection - contains metal powder mixed with crystalline carbon material at suitable proportion

PATENT-ASSIGNEE: OSAKA GAS CO LTD (OSAG)

PRIORITY-DATA: 1996JP-0329407 (December 10, 1996)

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ABSTRACTED-PUB-NO: JP10168502A
BASIC-ABSTRACT:

The material contains metal powders of Fe, Cu, Al, Ag, Be, Mg, W, Ni, Mo, Si and Zn. Crystalline carbon materials like graphite, carbon fibre, carbon black, fullerene is mixed with the metal powder at suitable proportion.

ADVANTAGE - Improves hydrophilicity, mechanical strength and corrosion resistance nature. Excels in heat conductivity.

ABSTRACTED-PUB-NO: JP10168502A
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MATSUI TAKEO

(54) **COMPOSITE MATERIAL WITH HIGH THERMAL CONDUCTIVITY**

(57) Abstract:

PROBLEM TO BE SOLVED: To provide a material of a high thermal conductivity, excellent in thermal conductivity, hydrophilic property, and corrosion resistance and useful for a substitute material for copper, aluminum, etc., conventionally used in a heat radiation plate for protection of an electric circuit and in thermal machinery, such as a heat exchanger and heat pump.

SOLUTION: A mixture is prepared by mixing 100 pts.wt. of metal powder (Fe, Cu, Al, Ag, Be, Mg, W, Ni, Mo, Si, Zn, etc.) and 1-200 pts.wt. of crystalline carbon material (graphite, carbon fiber, carbon black, fullerene, carbon nano- tube, etc.). This mixture is refined under pressurization and compounded. The resultant composite material grains are hot-press-compacted. By this method, the compound material with high thermal conductivity, having a structure in which the metal powder, e.g. of 5μm to 1nm average grain size is dispersed in the crystalline carbon matrix, can be obtained.

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(54)【発明の名称】高熱伝導率複合材

(57)【要約】
【課題】　熱伝導率、親水性及び耐食性に優れ、電気回路保護用の放熱板、熱交換器やヒートポンプ等の熱的機械において、従来使用されている銅やアルミニウム等の代替材料として有用な高熱伝導材を提供する。
【解決手段】　金属粉末（Fe、Cu、Al、Ag、Be、Mg、W、Ni、Mo、Si、Zn等）と結晶性カーボン材（黒鉛、炭素繊維、カーボンブラック、フラーレン、カーボンナノチューブ等）とを混合し、加圧微細化・複合化させて得られる複合材粒子をホットプレス成形して結晶性カーボンマトリックスに例えば、平均粒子径5μm〜1nmの金属粉末が分散した組織を有する高熱伝導率複合材を得る。

【特許請求の範囲】

【請求項１】　金属粉末と結晶性カーボン材とを混合し、加圧微細化・複合化させることにより得られる複合材粒子。

【請求項２】　金属粉末と結晶性カーボン材との混合割合が、金属粉末１００重量部に対して結晶性カーボン材１～２００重量部である請求項１に記載の複合材粒子。

【請求項３】　金属粉末が、Ｆｅ、Ｃｕ、Ａｌ、Ａｇ、Ｂｅ、Ｍｇ、Ｗ、Ｎｉ、Ｍｏ、Ｓｉ及びＺｎからなる群から選ばれた金属の粉末又は前記群から選ばれた金属を含む合金の粉末から選ばれた１種類又は２種類以上である請求項１又は２に記載の複合材粒子。

【請求項４】　結晶性カーボン材が、黒鉛、炭素繊維、カーボンブラック、フラーレン又はカーボンナノチューブから選ばれた１種類又は２種類以上である請求項１～３のいずれかに記載の複合材粒子。

【請求項５】　請求項１～４のいずれかに記載の複合材粒子をホットプレス成形することにより得られる高熱伝導率複合材。

【請求項６】　結晶性カーボンマトリックスに平均粒子径が５μｍ～１ｎｍの金属粉末が分散した組織を有する高熱伝導率複合材。

【請求項７】　請求項１～４のいずれかに記載の複合材粒子をホットプレス成形することにより得られる請求項６に記載の高熱伝導率複合材。

【請求項８】　金属粉末と結晶性カーボン材とを混合し、加圧微細化・複合化させる複合材粒子の製造法。

【請求項９】　金属粉末と結晶性カーボン材との混合割合が、金属粉末１００重量部に対して結晶性カーボン材１～２００重量部である請求項８に記載の複合材粒子の製造法。

【請求項１０】　金属粉末が、Ｆｅ、Ｃｕ、Ａｌ、Ａｇ、Ｂｅ、Ｍｇ、Ｗ、Ｎｉ、Ｍｏ、Ｓｉ及びＺｎからなる群から選ばれた金属の粉末又は前記群から選ばれた金属を含む合金の粉末から選ばれた１種類又は２種類以上である請求項８又は９に記載の複合材粒子の製造法。

【請求項１１】　結晶性カーボン材が、黒鉛、炭素繊維、カーボンブラック、フラーレン又はカーボンナノチューブから選ばれた１種類又は２種類以上である請求項８～１０のいずれかに記載の複合材粒子の製造法。

【請求項１２】　金属粉末と結晶性カーボン材との加圧微細化・複合化をボールミルで行なう請求項８～１１のいずれかに記載の複合材粒子の製造法。

【請求項１３】　金属粉末と結晶性カーボン材との加圧微細化・複合化を不活性ガス雰囲気中４０℃以下の低温で行なう請求項８～１２のいずれかに記載の複合材粒子の製造法。

【請求項１４】　請求項１～４のいずれかに記載の複合材粒子をホットプレス成形する高熱伝導率複合材の製造法。

【請求項１５】　ホットプレス成形を不活性雰囲気中２０～１５００℃で行なう請求項１４に記載の高熱伝導率複合材の製造法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、高熱伝導率複合材及びその製造法に関する。本発明は、高熱伝導率複合材の製造用材料として好適な複合材粒子及びその製造法に関する。本発明の高熱伝導率複合材は、電気回路保護用の散熱板、熱交換器やヒートポンプ等の熱的機械の高熱伝導性が要求される構築材料として有用である。

【０００２】

【従来の技術】従来、熱交換、熱伝達の現象を伴う熱的機械又は散熱用の汎用熱伝導材としては、主に鋳鉄、ステンレス鋼、銅及び銅合金、アルミニウム及びアルミニウム合金、ニッケル及びニッケル合金、チタン及びチタン合金、ジルコニウム合金等が使用されている。特に、高熱伝導率が要求される熱交換器等の熱的機械には、常温から高温までの温度範囲にわたって熱伝導率が最も高い銅やアルミニウム等が使用されている。

【０００３】しかし、現代社会においては、省エネルギーの技術に対する要望がますます高まっている中、より高い熱伝導率あるいは熱効率を有する熱的機械が求められており、銅やアルミニウム等に比べて、より高い熱伝導率を有する汎用熱伝導材を開発する必要がある。また、銅、アルミニウム等の金属を熱伝導材とする熱的機械においては、媒体と金属の濡れ性や酸性又はアルカリ性媒体による金属の腐食性といった点にも問題がある。

【０００４】

【発明が解決しようとする課題】本発明の目的は、電気回路保護用の放熱板、熱交換器やヒートポンプ等の熱的機械において、従来使用されている銅やアルミニウム等の代替材料となり得るように、高熱伝導率を有する高熱伝導材を提供することにあり、更に、高い親水性及び耐食性を有する新規高熱伝導材を提供することにある。

【０００５】

【課題を解決するための手段】本発明者らは、前記の目的に鑑み鋭意検討の結果、銅よりも熱伝導率が高い黒鉛や炭素繊維等の結晶性カーボン材と様々な金属を特定の方法により複合化させることにより、一般に熱的機械に使用されている銅よりも２倍以上高い熱伝導率を有するカーボンと金属の複合材が得られること、特に、結晶性カーボンマトリックスに金属粉末を微細に分散させた複合材が高熱伝導率を有することを見出した。

【０００６】本発明は、金属粉末（例えば、Ｆｅ、Ｃｕ、Ａｌ、Ａｇ、Ｂｅ、Ｍｇ、Ｗ、Ｎｉ、Ｍｏ、Ｓｉ及びＺｎからなる群から選ばれた金属の粉末又は前記群から選ばれた金属を含む合金の粉末から選ばれた１種類又は２種類以上）と結晶性カーボン材（例えば、黒鉛、炭素繊維、カーボンブラック、フラーレン又はカーボンナ

ノチューブから選ばれた１種類又は２種類以上）とを（例えば、金属粉末１００重量部に対して結晶性カーボン材１～２００重量部の混合割合で）混合し、加圧微細化・複合化させることにより得られる複合材粒子及びその製造法に関するものである。

【０００７】本発明は、当該複合材粒子をホットプレス成形することにより得られる高熱伝導率複合材及びその製造法に関するものである。本発明は、（例えば、前記複合材粒子をホットプレス成形することにより得られる）結晶性カーボンマトリックスに数平均粒子径が５μm～１nmの金属粉末が分散した組織を有する高熱伝導率複合材に関するものである。

【０００８】本発明の高熱伝導率複合材は、従来の銅やアルミニウム等を使用している熱的機械のための代替材として使用できるだけでなく、腐食性、親水性などの性能が要求される新規分野においてもその特性を発揮することができる。

【０００９】

【発明の実施の形態】

複合材粒子

金属粉末としては、Ｆｅ、Ｃｕ、Ａｌ、Ａｇ、Ｂｅ、Ｍｇ、Ｗ、Ｎｉ、Ｍｏ、Ｓｉ、Ｚｎ等の金属単体又はこれらの金属を１種類以上含む合金の粉末を使用することができる。金属粉末は１種類を単独で又は２種類以上を混合して使用することができる。熱伝導率の高い金属粉末、例えば、Ｃｕ、Ａｇ、Ａｌ、Ｂｅ等の粉末を使用することにより、より熱伝導率の高い複合材を得ることができる。

【００１０】結晶性カーボン材としては、天然黒鉛、人工合成黒鉛、炭素繊維、フラーレン、カーボンナノチューブ、その他の結晶性を有するカーボン材を使用することができる。結晶性カーボン材は粉末又は短繊維として使用することができる。結晶性カーボンは１種類を単独で又は２種類以上を混合して使用することができる。結晶性のよいカーボン材、例えば、天然黒鉛、人工合成黒鉛等を使用することにより、より熱伝導率の高い複合材を得ることができる。

【００１１】金属粉末と結晶性カーボン材との混合割合については、特に限定はないが、原料組成物中の金属粉末１００重量部に対して結晶性カーボン材１～２００重量部、好ましくは１０～１００重量部とすることにより、熱伝導率が高く且つ成形が容易な複合材を得ることができる。好ましい実施の形態では、複合材粒子は、金属粉末と結晶性カーボン材とが加圧・複合されたカーボン／金属の合金粉末であって、カーボンマトリックス中の金属粉末の平均粒子径が５μm～１nmである。

【００１２】金属粉末と結晶性カーボン材との混合材料の加圧微細化・複合化は、いわゆる機械的合金化処理することにより実施することができる。機械的合金化処理は、ボールミルを使用して混合・摩砕することにより実施することができる。好ましい実施の形態では、得られる複合材粒子のカーボンマトリックス中の金属粒子の平均粒子径が５μm～１nmとなるように混合材料の加圧微細化・複合化を行なう。

【００１３】混合材料の加圧微細化・複合化を不活性ガス雰囲気中で実施することが好ましく、また、４０℃以下、好ましくは３０℃以下、特に好ましくは０℃以下の低温で実施することが好ましい。混合材料の加圧微細化・複合化を不活性ガス雰囲気中３０℃以下の低温で実施することにより、カーボンマトリックス中に金属粒子が均一に分散した複合材を効率よく製造することができ、特に、不活性ガス雰囲気中０℃以下の低温で、例えばアルゴンガス雰囲気中、液体窒素で冷却しながら実施することにより、一層微細な複合材粒子を製造することができ、高熱伝導率複合材を製造するために都合がよい。

【００１４】金属粉末と結晶性カーボン材とを適当量配合して混在させ、これら混合粉末を加圧すれば、微細混合が進行し、各粒子の均一性が高まると共に、各粒子の有する性質に機能性が付加され、より高い性能と機能性を有する合金粒子、即ち、複合材粒子が生成する。特に加圧を、高エネルギーボールミル等を使用して、いわゆる機械的合金化処理により実施すると、各粒子は加工され偏平状になって新生面を露出し、この新生面どうしが鍛接され合体するようになって、このことが繰り返され、衝突・圧縮衝撃力により微細化と均質化が一層進行し、ミクロン以下nmオーダーの微細構造を有する複合材粒子が生成する。

【００１５】高熱伝導率複合材

複合材粒子を成形加工することにより、高熱伝導率複合材を製造することができる。特に、本発明の複合材粒子をホットプレス成形、即ち、加熱・加圧成形することにより優れた特性を有する高熱伝導率複合材を製造することができる。複合材粒子のホットプレス成形は、不活性雰囲気中２０～１５００℃で実施することができる。

【００１６】複合材粒子をホットプレス成形することにより、高熱伝導率複合材を得る過程において、ホットプレス成形を不活性ガス雰囲気中、適切な温度下で行うことが重要であり、成形圧力が高ければ高いほど、より緻密な複合材を製造することができ、熱伝導率や機械強度等の特性が良好な高熱伝導率複合材を得ることができる。例えば、銅パウダーと天然黒鉛パウダーから製造した銅／黒鉛合金パウダーを、アルゴン雰囲気中８００℃で１００００kg／cm^{2}の圧力で成形することにより銅板の２．３倍の熱伝導率を有する高熱伝導率複合材を製造することができる。

【００１７】

【実施例】以下に本発明の実施例と比較例を示し、本発明の特徴とするところをより一層明確にする。

【００１８】実施例１

銅パウダー（粒子径１００μm、純度９９．８％）９０

重量部に天然黒鉛（パウダー状、純度９９％）１０重量部を配合し、混合する。これら混合粉末と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、振動ボールミルによってアルゴンガス気流中、液体窒素で冷却しながら１２時間、いわゆる機械的合金化処理を行った。得られた合金粒子を８００℃、１００００ｋｇ／ｃｍ^{2}の圧力で空気を遮断した状態で円板状にホットプレス成形した。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００１９】実施例２

銅パウダー（粒子径１００μｍ、純度９９．８％）７０重量部に天然黒鉛（パウダー状、純度９９％）３０重量部を配合し、混合する。これら混合粉末と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、実施例１と同様な条件で、機械的合金化処理を行った。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２０】実施例３

銅パウダー（粒子径１００μｍ、純度９９．８％）５０重量部に天然黒鉛（パウダー状、純度９９％）５０重量部を配合し、混合する。これら混合粉末と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、実施例１と同様な条件で、機械的合金化処理を行った。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２１】実施例４

アルミニウム粉末（粒子径２００μｍ、純度９９．９％）７０重量部に天然黒鉛（パウダー状、純度９９％）３０重量部を配合し、混合する。これら混合粉末と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、実施例１と同様な条件で、機械的合金化処理を行った。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２２】実施例５

鉄粉末（粒子径２０～６０ｍｅｓｈ、純度９９．９％）７０重量部に天然黒鉛（パウダー状、純度９９％）３０重量部を配合し、混合する。これら混合粉末と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、実施例１と同様な条件で、機械的合金化処理を行った。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２３】実施例６

ニッケルパウダー（Ｔｙｐｅ２８７、純度９９．０％）７０重量部に人造黒鉛（石油コークスから製造されたもの、パウダー状、純度９９％）３０重量部を配合し、混

合する。これら混合粉末と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、実施例１と同様な条件で、機械的合金化処理を行った。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２４】比較例１

１００重量部の銅パウダー（粒子径１００μｍ、純度９９．８％）と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、振動ボールミルによってアルゴンガス気流中、液体窒素で冷却しながら１２時間、いわゆる機械的合金化処理を行った。得られた合金粒子を８００℃、１００００ｋｇ／ｃｍ^{2}の圧力で空気を遮断した状態で円板状にホットプレス成型した。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２５】比較例２

１００重量部のアルミニウム粉末（粒子径２００μｍ、純度９９．９％）と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、比較例１と同様な条件で機械的合金化処理を行った。得られた合金粒子を８００℃、１００００ｋｇ／ｃｍ^{2}の圧力で空気を遮断した状態で円板状にホットプレス成型した。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２６】比較例３

１００重量部の鉄粉末（粒子径２０～６０ｍｅＳｈ、純度９９．９％）と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、比較例１と同様な条件で機械的合金化処理を行った。得られた合金粒子を８００℃、１００００ｋｇ／ｃｍ^{2}の圧力で空気を遮断した状態で円板状にホットプレス成型した。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２７】比較例４

１００重量部のニッケルパウダー（Ｔｙｐｅ２８７、純度９９．０％）と１００重量部のステンレスボールを内容積２００ｍｌのステンレス鋼容器に仕込んで、比較例１と同様な条件で機械的合金化処理を行った。得られた合金粒子を８００℃、１００００ｋｇ／ｃｍ^{2}の圧力で空気を遮断した状態で円板状にホットプレス成型した。得られた円板状サンプルを室温でレーザーフラッシュ法による熱伝導率の測定を行った。その結果を表１に示す。

【００２８】

【表１】

7

8

表 1

実施例	組　　成	熱伝導率(W/m°K)
実施例1	天然黒鉛／銅＝10／90	526
実施例2	天然黒鉛／銅＝30／70	799
実施例3	天然黒鉛／銅＝50／50	963
実施例4	天然黒鉛／アルミニウム＝30／70	493
実施例5	天然黒鉛／鉄＝30／70	149
実施例6	人造黒鉛／ニッケル＝30／70	173
比較例1	銅＝100％	391
比較例2	アルミニウム＝100％	235
比較例3	鉄＝100％	78．5
比較例4	ニッケル＝100％	88．6

【0029】

【発明の効果】本発明によれば、単なる金属より2倍以上ほど高い熱伝導率複合材が得られる。本発明の高熱伝導率複合材は、耐腐食性や親水性や機械強度などの特性にも優れている。本発明の高熱伝導率複合材は、高熱伝導率を有し、しかも、様々な形状に加工することができるので、電気回路保護用の散熱板、熱交換器やヒートポンプ等の熱的機械の高熱伝導性が要求される構築材料として有用である。

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(54) COMPOSITE MATERIAL WITH HIGH THERMAL CONDUCTIVITY

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a material of a high thermal conductivity, excellent in thermal conductivity, hydrophilic property, and corrosion resistance and useful for a substitute material for copper, aluminum, etc., conventionally used in a heat radiation plate for protection of an electric circuit and in thermal machinery, such as a heat exchanger and heat pump.
SOLUTION: A mixture is prepared by mixing 100 pts.wt. of metal powder (Fe, Cu, Al, Ag, Be, Mg, W, Ni, Mo, Si, Zn, etc.) and 1-200 pts.wt. of crystalline carbon material (graphite, carbon fiber, carbon black, fullerene, carbon nano- tube, etc.). This mixture is refined under pressurization and compounded. The resultant composite material grains are hot-press-compacted. By this method, the compound material with high thermal conductivity, having a structure in which the metal powder, e.g. of 5μm to 1nm average grain size is dispersed in the crystalline carbon matrix, can be obtained.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to a high temperature conductivity composite and its manufacturing method. this invention relates to a composite particle suitable as the material of construction of a high temperature conductivity composite, and its manufacturing method. The high temperature conductivity composite of this invention is useful as a construction material as which the high temperature conductivity of thermal machines, such as a powder hot platen for electrical circuit protection, a heat exchanger, and heat pump, is required.
[0002]
[Description of the Prior Art] Conventionally, as the thermal machine accompanied by the phenomenon of a heat exchange and heat transfer, or general-purpose heat conductive guide members for ****, cast iron, stainless steel, copper and a copper alloy, aluminum and an aluminium alloy, nickel and a nickel alloy, titanium and the titanium alloy, the zirconium alloy, etc. are mainly used. Copper, aluminum, etc. with the highest thermal conductivity are used for thermal machines, such as a heat exchanger with which high temperature conductivity is demanded especially, over the temperature requirement from ordinary temperature to an elevated temperature.
[0003] However, while the requests to the technology of energy saving are mounting increasingly, the thermal machine which has higher thermal conductivity or higher thermal efficiency is called for, and compared with copper, aluminum, etc., it is necessary to develop the general-purpose heat conductive guide members which have higher thermal conductivity in modern society. Moreover, there is a problem also in points, such as the wettability of a medium and a metal, and corrosive [acidity or corrosive / of the metal by the alkaline medium], in the thermal machine which makes metals, such as copper and aluminum, heat conductive guide members.
[0004]
[Problem(s) to be Solved by the Invention] In thermal machines, such as a heat sink for electrical circuit protection, a heat exchanger, and heat pump, the purpose of this invention is to offer the high temperature conduction material which has high temperature conductivity, and is to offer the new high temperature conduction material which has still higher hydrophilic property and corrosion resistance so that it may become alternate material currently used conventionally, such as copper and aluminum.
[0005]
[Means for Solving the Problem] This invention persons wholeheartedly in view of the aforementioned purpose by making crystalline carbon material, such as a graphite with thermal conductivity higher than copper, and a carbon fiber, and various metals composite-ize by the specific method as a result of examination It found out that the composite of carbon and a metal which has high thermal conductivity more than double precision rather than the copper currently generally used for the thermal machine is obtained, and that the composite which made the crystalline carbon matrix distribute a metal powder minutely especially had high temperature conductivity.
[0006] this invention -- a metal powder (for example, Fe, Cu, aluminum, Ag, Be, and Mg --) One kind

or two kinds or more, and crystalline carbon material which were chosen from the powder of the alloy containing the metal chosen from the powder or the aforementioned group of the metal chosen from the group which consists of W, nickel, Mo, Si, and Zn (For example, one kind or two kinds or more which were chosen from a graphite, a carbon fiber, carbon black, fullerene, or the carbon nanotube) (for example, the metal-powder 100 weight section -- receiving -- mixed rate of the crystalline carbon material 1 - the 200 weight sections) it is related with the composite particle obtained and its manufacturing method by making it mix and composite[the formation of pressurization detailed, and]-ize

[0007] this invention relates to the high temperature conductivity composite obtained by carrying out hot hot pressing of the composite particle concerned, and its manufacturing method. this invention relates to the high temperature conductivity composite which has the organization which the metal powder whose number-average particle diameter is 5 micrometers - 1nm distributed to the crystalline (for example, obtained by carrying out hot pressing of the aforementioned composite particle) carbon matrix.

[0008] In the new field as which performances, such as corrosive and a hydrophilic property, are required, it not only can use the high temperature conductivity composite of this invention as an alternate material for the thermal machine which is using conventional copper, conventional aluminum, etc., but it can demonstrate the property.

[0009]

[Embodiments of the Invention]

As a composite particle metal powder, the powder of the alloy containing one or more kinds of metal simple substances or these metals, such as Fe, Cu, aluminum, Ag, Be, Mg, W, nickel, Mo, Si, and Zn, can be used. A metal powder is independent in one kind, or can mix and use two or more kinds. A composite with more high thermal conductivity can be obtained by using powder, such as a metal powder with high thermal conductivity, for example, Cu, Ag, aluminum, Be, etc.

[0010] As crystalline carbon material, a natural graphite, artificial synthetic graphite, a carbon fiber, fullerene, a carbon nanotube, and the carbon material that has other crystallinity can be used. Crystalline carbon material can be used as powder or a staple fiber. Crystalline carbon is independent in one kind, or can mix and use two or more kinds. A composite with more high thermal conductivity can be obtained by using crystalline good carbon material, for example, a natural graphite, artificial synthetic graphite, etc.

[0011] About the mixed rate of a metal powder and crystalline carbon material, although there is especially no limitation, a composite with fabrication thermal conductivity is high and easy can be obtained to the metal-powder 100 weight section in a raw material constituent the crystalline carbon material 1 - the 200 weight sections, and by considering as the 10 - 100 weight section preferably. With the form of desirable operation, it is a composite particle in the alloy-powder end of the carbon/metal with which a metal powder and crystalline carbon material were pressurized and compounded, and the mean particle diameter of the metal powder in a carbon matrix is 5 micrometers - 1nm.

[0012] The formation of pressurization detailed and composite-ization of the charge of an admixture of a metal powder and crystalline carbon material can be carried out by [so-called] carrying out mechanical-alloying processing. Mechanical-alloying processing can be carried out mixture and by grinding using a ball mill. With the form of desirable operation, the formation of pressurization detailed and composite-ization of the charge of an admixture are performed so that the mean particle diameter of the metal particles in the carbon matrix of the composite particle obtained may be set to 5 micrometers - 1nm.

[0013] It is desirable to carry out the formation of pressurization detailed and composite-ization of the charge of an admixture in inert gas atmosphere, and it is preferably desirable to carry out at low temperature 0 degree C or less preferably especially 30 degrees C or less 40 degrees C or less. By carrying out the formation of pressurization detailed and composite-ization of the charge of an admixture at low temperature 30 degrees C or less among inert gas atmosphere The composite which metal particles distributed uniformly in the carbon matrix can be manufactured efficiently. among inert gas atmosphere especially at low temperature 0 degree C or less For example, among argon gas atmosphere, by carrying out cooling by liquid nitrogen, it is convenient in order to be able to

manufacture a much more detailed composite particle and to manufacture a high temperature conductivity composite.
[0014] If carry out suitable amount combination, a metal powder and crystalline carbon material are made intermingled and the end of these mixed powder is pressurized, while detailed mixture will advance and the homogeneity of each particle will increase, functionality is added to the property which each particle has, and the alloy particle which has a higher performance and higher functionality, i.e., a composite particle, generates. If a high-energy ball mill etc. is used and especially pressurization is carried out by the so-called mechanical-alloying processing, each particle will be processed and will become flat [-like], a new field is exposed, and these new fields are forge-welded, it comes to coalesce, this is repeated, detailed-izing and homogenization advance further with collision / compression impulse force, and the composite particle which has the fine structure of below micron nm order generates.
[0015] A high temperature conductivity composite can be manufactured by carrying out the fabricating operation of the high temperature conductivity composite composite particle. The high temperature conductivity composite which has especially the property which was excellent hot pressing, i.e., heating, and by carrying out pressing in the composite particle of this invention can be manufactured. Hot pressing of a composite particle can be carried out at 20-1500 degrees C among an inert atmosphere.
[0016] In process in which a high temperature conductivity composite is obtained by carrying out hot pressing of the composite particle, the more it is important to perform hot pressing in inert gas atmosphere and under suitable temperature and a compacting pressure is high, a more precise composite can be manufactured and, the more properties, such as thermal conductivity and mechanical strength, can obtain a good high temperature conductivity composite. For example, the high temperature conductivity composite which has one 2.3 times the thermal conductivity of a copper plate can be manufactured by fabricating the copper / graphite alloy powder manufactured from copper powder and natural-graphite powder by 800 degrees C by the pressure of 10000 kg/cm2 among argon atmosphere.
[0017]
[Example] The example and the example of comparison of this invention are shown below, and the place by which it is characterized [of this invention] is clarified further. [0018] The natural-graphite (shape of powder, 99% of purity) 10 weight section is blended with the example 1 copper powder (100 micrometer [of particle diameters], 99.8% of purity) 90 weight section, and it mixes. The stainless steel ball of the end of these mixed powder and the 100 weight sections was taught to the stainless steel container of 200ml of content volume, and the so-called mechanical-alloying processing was performed for 12 hours, cooling by liquid nitrogen among an argon gas air current by the vibration ball mill. Where air is intercepted by the pressure of 800 degrees C and 10000 kg/cm2, hot pressing of the obtained alloy particle was carried out to disc-like. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.
[0019] The natural-graphite (shape of powder, 99% of purity) 30 weight section is blended with the example 2 copper powder (100 micrometer [of particle diameters], 99.8% of purity) 70 weight section, and it mixes. The stainless steel ball of the end of these mixed powder and the 100 weight sections was taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as an example 1. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.
[0020] The natural-graphite (shape of powder, 99% of purity) 50 weight section is blended with the example 3 copper powder (100 micrometer [of particle diameters], 99.8% of purity) 50 weight section, and it mixes. The stainless steel ball of the end of these mixed powder and the 100 weight sections was taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as an example 1. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.
[0021] The natural-graphite (shape of powder, 99% of purity) 30 weight section is blended with the example 4 aluminium-powder (200 micrometer [of particle diameters], 99.9% of purity) 70 weight

section, and it mixes. The stainless steel ball of the end of these mixed powder and the 100 weight sections was taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as an example 1. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.

[0022] The natural-graphite (shape of powder, 99% of purity) 30 weight section is blended with 70 ****** in the end (a particle diameter 20 - 60mesh, 99.9% of purity) of example 5 iron powder, and it mixes. The stainless steel ball of the end of these mixed powder and the 100 weight sections was taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as an example 1. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.

[0023] The artificial-graphite (shape of what [was manufactured from petroleum coke], and powder, 99% of purity) 30 weight section is blended with the example 6 nickel powder (Type287, 99.0% of purity) 70 weight section, and it mixes. The stainless steel ball of the end of these mixed powder and the 100 weight sections was taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as an example 1. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.

[0024] The copper powder (100 micrometers of particle diameters, 99.8% of purity) of the example of comparison 1100 weight section and the stainless steel ball of the 100 weight sections were taught to the stainless steel container of 200ml of content volume, and the so-called mechanical-alloying processing was performed for 12 hours, cooling by liquid nitrogen among an argon gas air current with an oscillating pole mill. Where air is intercepted by the pressure of 800 degrees C and 10000 kg/cm2, hotpress molding of the obtained alloy particle was carried out disc-like. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.

[0025] The stainless steel ball of the aluminium powder (200 micrometers of particle diameters, 99.9% of purity) of the example of comparison 2100 weight section and a 100 weight county was taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as the example 1 of comparison. Where air is intercepted by the pressure of 800 degrees C and 10000 kg/cm2, hotpress molding of the obtained alloy particle was carried out disc-like. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.

[0026] The stainless steel ball of the iron powder end of the example of comparison 3100 weight section (a particle diameter 20 - 60meSh, 99.9% of purity) and 100 ****** was taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as the example 1 of comparison. Where air is intercepted by the pressure of 800 degrees C and 10000 kg/cm2, hotpress molding of the obtained alloy particle was carried out disc-like. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.

[0027] The nickel powder (Type287, 99.0% of purity) of the example of comparison 4100 weight section and the stainless steel ball of the 100 weight sections were taught to the stainless steel container of 200ml of content volume, and mechanical-alloying processing was performed on the same conditions as the example 1 of comparison. Where air is intercepted by the pressure of 800 degrees C and 10000 kg/cm2, hotpress molding of the obtained alloy particle was carried out disc-like. The thermal conductivity according the obtained disc-like sample to a laser flash method was measured at the room temperature. The result is shown in Table 1.

[0028]

[Table 1]

表 1

実施例	組　成	熱伝導率(W/m°K)
実施例1	天然黒鉛／銅＝１０／９０	５２６
実施例2	天然黒鉛／銅＝３０／７０	７９９
実施例3	天然黒鉛／銅＝５０／５０	９６３
実施例4	天然黒鉛／アルミニウム＝３０／７０	４９３
実施例5	天然黒鉛／鉄＝３０／７０	１４９
実施例6	人造黒鉛／ニッケル＝３０／７０	１７３
比較例1	銅＝１００％	３９１
比較例2	アルミニウム＝１００％	２３５
比較例3	鉄＝１００％	７８．５
比較例4	ニッケル＝１００％	８８．６

[0029]
[Effect of the Invention] According to this invention, a thermal conductivity composite as high than a mere metal as more than double precision is obtained. The high temperature conductivity composite of this invention is excellent also in properties, such as a corrosion resistance, a hydrophilic property, and mechanical strength. Since the high temperature conductivity composite of this invention has high temperature conductivity and can moreover process various configurations, it is useful as a construction material as which the high temperature conductivity of thermal machines, such as a powder hot platen for electrical circuit protection, a heat exchanger, and heat pump, is required.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The composite particle obtained by making a metal powder and crystalline carbon material mix and composite[the formation of pressurization detailed, and]-ize.
[Claim 2] The composite particle according to claim 1 whose mixed rates of a metal powder and crystalline carbon material are the crystalline carbon material 1 - the 200 weight sections to the metal-powder 100 weight section.
[Claim 3] The composite particle according to claim 1 or 2 which is one kind chosen from the powder of the alloy with which a metal powder contains the metal chosen from the powder or the aforementioned group of the metal chosen from the group which consists of Fe, Cu, aluminum, Ag, Be, Mg, W, nickel, Mo, Si, and Zn, or two kinds or more.
[Claim 4] The composite particle according to claim 1 to 3 whose crystalline carbon material is one kind chosen from a graphite, a carbon fiber, carbon black, fullerene, or the carbon nanotube, or two kinds or more.
[Claim 5] The high temperature conductivity composite obtained by carrying out hot pressing of the composite particle according to claim 1 to 4.
[Claim 6] The high temperature conductivity composite which has the organization which the metal powder whose mean particle diameter is 5 micrometers - 1nm distributed to the crystalline carbon matrix.
[Claim 7] The high temperature conductivity composite according to claim 6 obtained by carrying out hot pressing of the composite particle according to claim 1 to 4.
[Claim 8] The manufacturing method of the composite particle which makes a metal powder and crystalline carbon material mix and composite[the formation of pressurization detailed, and]-ize.
[Claim 9] The manufacturing method of the composite particle according to claim 8 whose mixed rates of a metal powder and crystalline carbon material are the crystalline carbon material 1 - the 200 weight sections to the metal-powder 100 weight section.
[Claim 10] The manufacturing method of the composite particle according to claim 8 or 9 which is one kind chosen from the powder of the alloy with which a metal powder contains the metal chosen from the powder or the aforementioned group of the metal chosen from the group which consists of Fe, Cu, aluminum, Ag, Be, Mg, W, nickel, Mo, Si, and Zn, or two kinds or more.
[Claim 11] The manufacturing method of the composite particle according to claim 8 to 10 whose crystalline carbon material is one kind chosen from a graphite, a carbon fiber, carbon black, fullerene, or the carbon nanotube, or two kinds or more.
[Claim 12] The manufacturing method of the composite particle according to claim 8 to 11 which performs the formation of pressurization detailed and composite-ization with a metal powder and crystalline carbon material with a ball mill.
[Claim 13] The manufacturing method of the composite particle according to claim 8 to 12 which performs the formation of pressurization detailed and composite-ization with a metal powder and crystalline carbon material at low temperature 40 degrees C or less among inert gas atmosphere.

[Claim 14] The manufacturing method of the high temperature conductivity composite which carries out hot pressing of the composite particle according to claim 1 to 4.
[Claim 15] The manufacturing method of the high temperature conductivity composite according to claim 14 which performs hot pressing at 20-1500 degrees C among an inert atmosphere.

[Translation done.]